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$A'OB' - C'$, and the cone $AOB - C$ will be compressed into the cone $AOB - I$.

The volume of the *compressed* string-cone, $AOB - I$, becomes

$$W_1 = M_1 g = V_1 \delta_1 g = \frac{1}{3} \pi r_1^2 (r_1 \tan \omega_1 - m_1) \delta_1 g \dots (2).$$

Equating the right-hand members of (1) and (2), we have

$$\delta_1 = \left(\frac{r_1 \tan \omega_1}{r_1 \tan \omega_1 - m_1} \right) \delta_0, \dots, \delta_n = \left(\frac{r_1 \tan \omega_1}{r_1 \tan \omega_1 - m_n} \right) \delta_1 \dots (3).$$

The values of $\delta_1 \dots \delta_n$, as determined empirically for determinate conditions, immediately lead to the required law of density.

18. Proposed by ALFRED HUME, C. E., D. Sc., Professor of Mathematics, University of Mississippi, University, Mississippi.

An elliptic paraboloid whose equations is $\frac{y^2}{a} + \frac{x^2}{b} = 2z$ has its axis vertical and vertex downward. If μ be the co-efficient of friction, prove that a heavy particle will rest at any point of the surface below its intersection with the cylinder $\frac{y^2}{a^2} + \frac{x^2}{b^2} = \mu^2$.

Solution by the PROPOSER.

If W is the weight of the particle, N and T its normal and tangential components, $W^2 = N^2 + T^2$. Also, when the particle is on the point of sliding, $T = \mu N$. Hence, $W^2 = (1 + \mu^2) N^2$. Again, $W \cos \theta = N$, θ being the angle between the normal and the Z -axis.

$$\text{Now } \cos \theta = \frac{\frac{dF}{dz}}{\sqrt{\left(\frac{dF}{dx}\right)^2 + \left(\frac{dF}{dy}\right)^2 + \left(\frac{dF}{dz}\right)^2}}, \quad F(x, y, z) = 0 \text{ being the equation}$$

of the surface, and the differential-coefficients being partial.

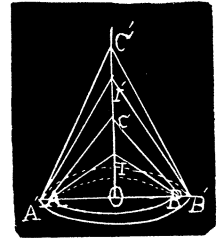
$$\frac{dF}{dx} = \frac{2x}{b}, \frac{dF}{dy} = \frac{2y}{a}, \frac{dF}{dz} = -2. \quad \text{Substituting, } \cos^2 \theta = \frac{-2}{\sqrt{\left(\frac{4x^2}{b^2} + \frac{4y^2}{a^2} + 4\right)}}.$$

This, in the fourth equation above, gives, after squaring,

$$N^2 = \frac{4 W^2}{\frac{4x^2}{b^2} + \frac{4y^2}{a^2} + 4}. \quad \text{Substituting this value of } N^2 \text{ in the third equation}$$

and reducing we get $\frac{y^2}{a^2} + \frac{x^2}{b^2} = \mu^2$.

This is the relation between the x and y co-ordinates of every point of the surface at which the friction is limiting; in other words, these points lie on the cylindrical surface of which this is the equation. Consequently, their locus



is the curve of intersection of the paraboloid and the cylinder. This curve divides the given surface into two parts. The particle will be in equilibrium at any point of the lower and at no point of the upper.

Two excellent solutions of this problem were received from *F. P. Matz*, and one from *G. B. M. Zerr*.

PROBLEMS.

26. Proposed by *F. P. MATZ*, M. Sc., Ph. D., Professor of Mathematics and Astronomy in New Windsor College, New Windsor, Maryland.

If an elastic sphere be electrified in such a manner that the initial internal pressure remains constant, determine an expression for the *ratio of the electrical densities* when the volume of the sphere has been increased to $(m+1)$ times its initial volume.

DIOPHANTINE ANALYSIS.

Conducted by *J. M. COLAW*, Monterey, Va. All contributions to this department should be sent to him.

SOLUTIONS OF PROBLEMS.

20. Proposed by *G. B. M. ZERR*, A. M., Principal of High School, Staunton, Virginia.

Find two integral numbers, whose sum, difference, and difference of their squares shall be a square, cube, and fourth power.

I. Solution by *J. H. DRUMMOND*; *H. C. WILKES*; and *M. A. GRUBER*.

Let x and y = the two integral numbers. Any number to be a square, a cube, and a fourth power, must also be a twelfth power.

$$\text{Then } x+y=a^{12}$$

$$x-y=b^{12}$$

$$x^2-y^2=a^{12}b^{12}=(ab)^{12}.$$

$$\text{Whence } x=\frac{1}{2}(a^{12}+b^{12}), \text{ and } y=\frac{1}{2}(a^{12}-b^{12}).$$

In order that x and y be integral, a^{12} and b^{12} must be both odd or both even.

Put $a^{12}=5^{12}=244,140,625$ and $b^{12}=3^{12}=531441$. Then $x=122,336,033$ and $y=121,804,592$. Put $a^{12}=6^{12}=2,176,782,336$ and $b^{12}=2^{12}=4096$. Then $x=1,088,393,216$ and $y=1,088,389,120$.

The lowest values of x and y are found by putting

$$x+y=a^{12}=3^{12}=531441,$$

$$x-y=b^{12}=1^{12}=1.$$

$$\text{Whence } x=265721 \text{ and } y=265720.$$

Many answers can be obtained but the work will be tedious.